THE MARS SAMPLE RETURN ANALOGUE SAMPLE LIBRARY. M. T. Thorpe[1], M. A. Velbel[2], E. Hauber[3], K. T. Tait[4], F. Thiessen[5], E. Sefton-Nash[6], M. Ciocco[7], A. Krzesinska[8], S.C. Werner[9], A. B. Müller[7,8], L. Griffiths[9], T. D. Mikesell[9], and the MSR Campaign Science Group (MCSG). [1]University of Maryland, NASA GSFC, CRESST II (michael.t.thorpe@nasa.gov), [2]Michigan State University, [3]DLR-Institut für Planetenforschung, [4]Royal Ontario Museum and University of Toronto, [5]Max-Planck-Institute for Solar System Research, [6]European Space Agency, [7]University of Oslo, [8]Oslo Natural History Museum, [9]Norwegian Geotechnical Institute.

Introduction: As of sol 1363, the Mars 2020 Perseverance rover has sealed 28 tubes and still has the ability to collect an additional 13 more geological samples. With each additional sample, the potential Mars Sample Return (MSR) cache continues to become more scientifically valuable, particularly as Perseverance embarks on the Crater Rim Campaign. Regardless of the additional samples, even the current suite of samples represents a scientifically return-worthy cache [1], spanning a range of primary igneous textures [2-3], providing compelling lines of evidence for a rich weathering, sedimentation, and diagenetic history in the ancient Jezero watershed [4], and even the potential of organic preservation [5]. These samples will enable studies of Mars' geological and astrobiological history as well as larger scale investigations of planetary evolution in ways previously unimaginable. Additionally, the MSR cache also holds the potential to inform on potential risks and opportunities for future human missions to the surface of Mars.

Before these precious samples are interrogated in the state-of-the-art laboratories on Earth, extensive testing of analogues is necessary to fully prepare for engineering, science, curation, and planetary protection needs. Therefore, multiple teams branching from the MSR Campaign Science Group (MCSG) have been chartered to strategically select natural samples from the field that best represent discrete components of the Jezero samples. Collectively, these samples make up the MSR Analogue Sample Library (ASL), a repository jointly hosted by NASA and ESA and curated at the Natural History Museum, University of Oslo, Norway. The MSR ASL is designed to serve as a resource for the MSR team and Sample Receiving Project (SRP) but also for the broader scientific community. Here, we will discuss the current ASL, the process for requesting samples, and the future of the ASL.

Current ASL Collection: In 2023 the Rock Sample Team (RST), a group of scholars around the globe, was tasked to help identify field sites from which to collect physically representative Mars analogues. These original samples were designed to serve engineering needs related to sample receiving and processing. The MSR target samples for these physical analogues included mainly those deposited at the Three Forks Depot. The RST solicited input from the community and developed an extensive list of potential analogues before narrowing down the 2023 field season to five candidates [6-7]. With field teams built from both NASA and ESA representatives, as well as members from the Mars 2020 Science team, the first samples were collected for the ASL (Fig. 1). These samples include (*letters correlate to Fig. 1*) (A) holocrystalline basalts, both aphyric and plagioclase-phyric, from Oregon, USA, (E) olivine cumulates from Scotland, (B) carbonate cemented and (C) carbonate-gypsum cemented fine sandstones/siltstones from California, and (D) eolian volcanic sands from Iceland. These analogues targets the physical characteristics of the following Jezero crater regions or MSR samples: the

Figure 1. A map displaying the locations of the field campaigns designated by the RSL in 2023. Pictures from the field teams are highlighted in inserts A-E.

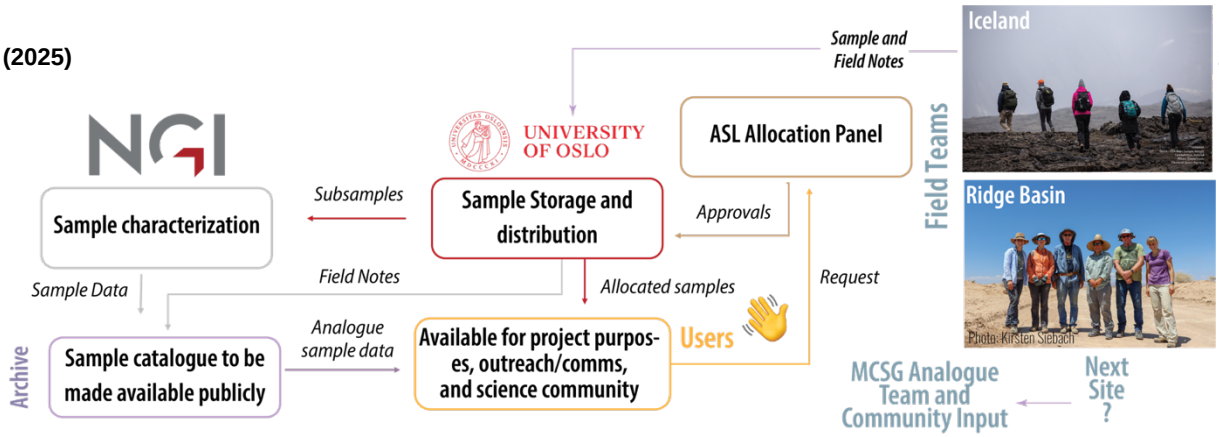

Figure 2. Flowchart documenting everything from sample collection to allocation to curation.

Máaz formation (A), the Séítah formation (E), sedimentary samples from the Fan Campaigns (B-C), and the Atmo Mountain and Crosswind Lake regolith samples (D). More detailed information on the ASL samples and the target MSR samples can be found on the ASL website (displayed below), also linked with a QR code below.

Requesting samples from the ASL: The ASL provides a joint (NASA and ESA) way to identify, acquire and manage suitable analogue samples for the benefit of the MSR Campaign, for the Mars (and wider) science community and for education and communication to the public. As of November 14th, 2024, samples can be requested from the ASL, with the priority of sample allocation flowing from the MSR and SRP campaign, to the scientific community, and then finally, perhaps most importantly, to public relations and outreach. The full picture from the field collection to allocation and curation is detailed in Figure 2. The ASL also includes comprehensive baseline sample characterization by the Norwegian Geotechnical Institute (NGI), with reports available to the community.

Future of the ASL and Ongoing Work: Building on the foundation from the RST, the MCSG chartered a new sub-team tasked to critically evaluate the current collection and identifying any areas that needed to be supplemented. Since the original ASL samples collected in 2023, an additional 11 rock cores have been added to the MSR cache, thus the current ASL is missing compositional endmembers. Additionally previous physical analogues in the ASL are being re-evaluated for compositional (e.g., geochemical and mineralogical) viability. The goal of the MCSG Analogue team is to create a more robust, i.e., representative, ASL for the community to work with. To best evaluate the compositional fit for MSR samples, a rubric for quality-of-match criteria was developed. Using this rubric, the team highlighted key features and attributes in the MSR cache and performed a detailed exercise of running each current and proposed analog through this rubric to assess the compositional comparability. Preliminary work by the MCSG has already identified some key recommendations to make the current MSR Analog collection more comprehensive. Moreover, MCSG team members have already conducted reconnaissance field campaigns to supplement the current MSR Analog collection, with sites in Iceland and Italy (Fig. 1). The MCSG also plans to turn their attention to re-examine both the igneous and regolith samples analogs. Finally, the MCSG plans to continuously to build the ASL as the Perseverance rover continues to diversify its cache.

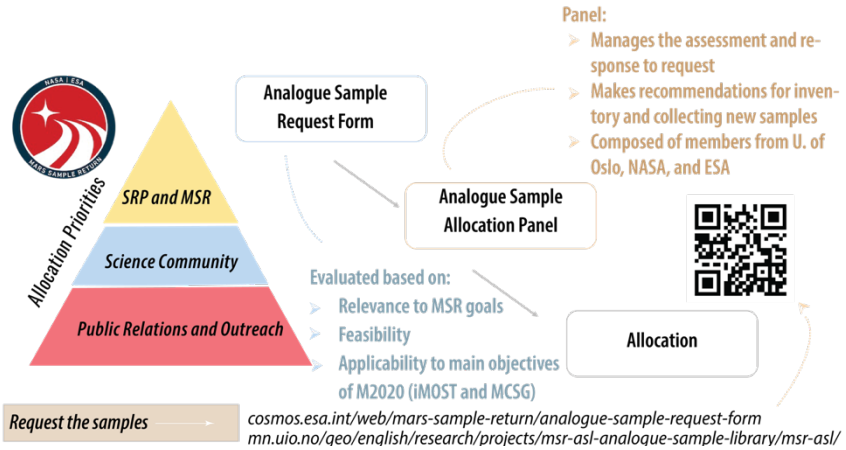

Figure 3. An overview of the sample allocation processes as well as a QR code to request samples.

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References: [1] Czaja et al., (2023), *Meteoritics & Planetary Science*; [2] Udry et al., (2023), *JGR-Planets*; [3] Horgan et al., (2023), *JGR-Planets*; [4] Tice et al., (2022), Science; [5] Scheller et al., (2022), *Science*; [6] Beaty and Siebach (2023) *AGU townhall*; [7] Thiessen et. al., (2024) *LPI Contribution* 3040,1208,